PVP 23

Code: 23HS1403

II B.Tech - II Semester – Regular Examinations – MAY 2025

OPTIMIZATION TECHNIQUES

(Common for IT, AIML, DS)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	Define slack variable and surplus variables.	L2	CO1
1.b)	What are the merits of operations Research?	L2	CO1
1.c)	Discuss about degeneracy in Transportation problem.	L2	CO1
1.d)	How to convert maximization assignment problem into minimization problem.	L2	CO1
1.e)	Write a note on types of sequencing problems?	L2	CO1
1.f)	Discuss general guidelines need to follow while drawing project network diagrams.	L2	CO1
1.g)	Explain different types of inventory models.	L2	CO1
1.h)	Explain cost management in Break-even-Analysis.	L2	CO1
1.i)	Define saddle point and value of the game.	L2	CO1
1.j)	What is the role of theory of games in scientific decision making?	L2	CO1

PART – B

			BL	CO	Max. Marks
UNIT-I					
2		Solve the following LPP using graphical method *Maximize* $z = 20x_1 + 10x_2$ subject to $2x_1 + 3x_2 \geq 30,\ 3x_1 + 2x_2 \leq 24,\ x_1 + x_2 \geq 3$ *and* $x_1, x_2 \geq 0$	L3	CO2	10 M

			BL	CO	Max. Marks
UNIT-V					
10		Using the graphical method, Solve the following game and the value of the game.	L4	CO5	10 M

Player A	Player B				
	1	2	3	4
A1	2	2	3	-2
A2	4	3	2	6

OR

11		A Glass factory specializing in crystal is developing a substantial backlog and the firm's management is considering three courses of action: (A) arrange for sub-contracting (B) overtime (C) construct new facilities. The correct choice depends largely upon future demand which may be low, medium or high. By consensus, management ranks the respective probabilities as 0.10, 0.50 and 0.40. A cost analysis reveals the effect upon the profits that is shown in the table below.	L4	CO5	10 M

Profit (Rs. '000) if demand is	Courses of action		
	A (subcontracting)	B (over time)	C (construct facilities)
Low (p=0.10)	10	-20	-150
Medium (p=0.50)	50	60	20
High (p=0.40)	50	100	200

Show this decision is in the form of a decision tree and indicates the most preferred decision and corresponding expected value.

OR

3	Use simplex method to solve the following LPP $Maximize\ z = 3x_1 + 5x_2 + 4x_3$ subject to $2x_1 + 3x_2 \le 8,\ 2x_2 + 5x_3 \le 10,\ 3x_1 + 2x_2 + 4x_3 \le 15$ $and\ x_1, x_2, x_3 \ge 0$	L3	CO2	10 M

UNIT-II

4	Determine an optimal solution to the following Transportation problem.	L3	CO2	10 M

	D_1	D_2	D_3	D_4	Supply
O_1	1	2	1	4	30
O_2	3	3	2	1	30
O_3	4	2	5	9	20
Demand	20	40	30	10	

OR

5	A market manager has 5 salesmen and there are 5 sales districts. Considering the capabilities of the salesmen and the nature of districts, the estimates made by the marketing manager for the sales per month(in 1000 rupees) for each salesman in each district would be as follows. $\begin{bmatrix} 32 & 38 & 40 & 28 & 40 \\ 40 & 24 & 28 & 21 & 36 \\ 41 & 27 & 33 & 30 & 37 \\ 22 & 38 & 41 & 36 & 36 \\ 29 & 33 & 40 & 35 & 39 \end{bmatrix}$ Find the assignment to the districts that will result in the maximum sales.	L3	CO2	10 M

UNIT-III

6	There are seven jobs each of which has to go through the machines M_1, M_2 in the order of M_1, M_2. Processing time (in hours) is given as	L3	CO3	10 M

Job	1	2	3	4	5	6	7
Machine M_1	3	12	15	6	10	11	9
Machine M_2	8	10	10	6	12	1	3

Determine the sequence of these jobs that will minimize the total elapsed time. Also find the idle times of machines.

OR

7	A project has the following characteristics	L3	CO3	10 M

Activity	Most Optimistic time	Most likely time	Most pessimistic time
(1 – 2)	1	1.5	5
(2 – 3)	1	2	3
(2 – 4)	1	3	5
(3 – 5)	3	4	5
(4 – 5)	2	3	4
(4 – 6)	3	5	7
(5 – 7)	4	5	6
(6 – 7)	6	7	8
(7 – 8)	2	4	6
(7 – 9)	5	6	8
(8 – 10)	1	2	3
(9 – 10)	3	5	7

Construct a PERT Network. Also find the critical path and variance for each event.

UNIT-IV

8	The following table gives the annual demand and unit price of the item.	L4	CO4	10 M

Item	A
Annual demand (units)	400
Unit Price (Rs)	8.00

Order cost is Rs5 per order and holding cost is 10% of unit price. Determine (i) EOQ. (ii) Total Inventory cost. (iii) Number of orders in a year.

OR

9	If sales are 10,000 units and selling price is Rs. 20 per unit, variable cost is Rs.10 per unit and fixed cost is Rs.80,000/-. Find out BEP in units and sales revenue. What is the profit earned? What should be the sales for earning profit of Rs.60,000/-?	L4	CO4	10 M

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SCHEME OF EVALUATION

PART – A

1.a) Define slack variable and surplus variables.

Slack Variable -1 Mark

Surplus Variable -1 Mark.

1.b) What are the merits of operations Research?

Any 4 merits 2 Marks

1.c) Discuss about degeneracy in Transportation problem.

Degeneracy Formula 1 Mark Explanation 1 Mark

1.d) How to convert maximization assignment problem into minimization problem?

Explanation 2 Marks

1.e) Write a note on types of sequencing problems.

Any 2 types 2 Marks

1.f) Discuss general guidelines need to follow while drawing project network diagrams.

Rules for network construction: Any 4 Rules 2 Marks

1.g) Explain different types of inventory models.

Any 2 types 2 Marks

1.h) Explain cost management in Break-even-Analysis.

Explanation 2 marks.

1.i) Define saddle point and value of the game.

Saddle Point-1 Mark

Value of the Game-1 Mark

1.j) What is the role of theory of games in scientific decision making?

Explanation – 2 marks:

PART – B

UNIT-I

2. Graphical Solution:

Points identification- 4 Marks

Graph - 4 Marks

Solution- 2 Marks

3. Conversion to std. form- 2 Marks

Basic Solution – 2 Marks

Simplex table-1 Mark

Iterations and final solution- 5 marks

UNIT-II

4. Transportation Problem:

Basic feasible solution- VAM- 7 Marks

U-V Method- 3 Marks

Note: Basic Feasible Solution can be done using Northwest corner or Least cost method.

Marks will be given proportionately

5. Assignment Problem:

Conversion from Maximization to minimization -2 marks

Row reduction and Column reduction – 2 Marks

Allocation- 4 marks

Final allocation and total sales- 2Marks

UNIT-III

6. Job Sequencing:

Job Sequence– 3 Marks

Total elapsed time calculation Table- 5 Marks

Idle time- 2Marks

7. PERT:

Estimated time and Variance calculation- 3 Marks

Network Diagram -4 marks

Project duration calculation and table- 3 Marks

UNIT-IV

8. EOQ Problem:

Given Data- 1 Mark

i) EOQ- Formula -1 Mark, Substitution and Solution- 2 marks

ii) Total Inventory cost- Formula -1 Mark, Substitution and Solution- 2 marks

iii) Number of Orders- Formula -1 Mark, Substitution and Solution- 2 marks

9. Break Even Analysis:

Given Data- 1 Mark

Break-Even Point (BEP):

(a) BEP in units: - 2 Marks

(b) BEP in sales revenue:- 2 Marks

Profit Earned – 2Marks

Required Sales to Earn Profit of Rs. 60,000- 3 Marks

UNIT-V

10. Game theory Graphical solution:

Graph- 5 Marks

Value of Game- 1 Mark

Mixed strategy probabilities- 4 marks (for both players)

11. Decision Tree:

Given Data: 2 Marks

Decision tree- 3 Marks

EMV Calculation – 3 Marks

Final decision- 2 Marks

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II B.Tech - II Semester - Regular Examinations – MAY 2025
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PART – A

1.a) Define slack variable and surplus variables.

In linear programming, slack and surplus variables are used to convert inequalities into equalities.

Slack Variable is used in: $\leq$ (less than or equal to) constraints.

Surplus Variable is used in: $\geq$ (greater than or equal to) constraints.

1.b) What are the merits of operations Research?

1. Improved Decision-Making
2. Optimal Resource Utilization
3. Enhanced Productivity
4. Better Forecasting and Planning
5. Risk Reduction
6. Cost Reduction

1.c) Discuss about degeneracy in Transportation problem.

A transportation problem is said to have **degeneracy** when:

$$\text{Number of allocations} < (m+n-1)$$

Where: m = number of rows (sources)
n = number of columns (destinations)

To resolve degeneracy:

Introduce a very small value 'ε'($\varepsilon \to 0$) in one or more unoccupied cells to increase the number of allocations to $m+n-1$.

1.d) How to convert maximization assignment problem into minimization problem?

To convert a maximization assignment problem into a minimization problem, subtract each element in the matrix from the maximum value in the entire matrix.

1.e) Write a note on types of sequencing problems.

- Two Machines and n Jobs Problem
- Three Machines and n Jobs Problem
- n Jobs and m Machines Problem

1.f) Discuss general guidelines need to follow while drawing project network diagrams.

Rules for network construction:

The following are the primary rules for constructing network diagram.

1. The starting event and ending event of an activity are called tail event and head event, respectively.
2. The network should have a unique starting node (tail event).
3. The network should have a unique completion node (head event).
4. No activity should be represented by more than one arc in the network.
5. No two activities should have the same starting node and the same ending node.
6. Dummy activity is an imaginary activity indicating precedence relationship only. Duration of a dummy activity is zero.

1.g) Explain different types of inventory models.

- Purchase Model
- Production or Manufacturing model
- Shortage model
- Quantity discounts model

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1.h) Explain cost management in Break-even-Analysis.

Cost management in Break-even Analysis involves identifying and managing fixed costs (costs that remain constant regardless of production level) and variable costs (costs that change with the level of output), with the goal of determining the break-even point where total revenue equals total costs. This analysis helps businesses make informed decisions about pricing, production levels, and cost control strategies to achieve profitability.

1.i) Define saddle point and value of the game.

Saddle Point:

Maximin= Minimax

In game theory, a saddle point refers to a specific position in a payoff matrix where the value of Maximin is equal to Minimax value.

Value of the Game:

The value of the game is the expected payoff that a player can achieve when both players adopt optimal strategies.

1.j) What is the role of theory of games in scientific decision making?

Role of Theory of Games in Scientific Decision Making:

Theory of Games plays a crucial role in scientific decision-making by providing a structured approach to analyzing and predicting the outcomes of competitive situations where multiple decision-makers (or players) interact and helping decision-makers anticipate actions of others and make informed choices in competitive scenarios.

PART-B

UNIT-1

2. Solve the LPP using graphical method Maximize $x = 20x_1 + 10x_2$ subject to $2x_1 + 3x_2 >= 30$; $3x_1 + 2x_2 <= 24$; $x_1 + x_2 >= 3$ and $x_1, x_2 >= 0$ 10 Marks

Sol:

From $2x_1 + 3x_2 >= 30$

When $x_1=0$ then x_2=?

$\Rightarrow 2(0)+3x_2=30$

$\Rightarrow 3x_2=30 \Rightarrow x_2= 30/3=10$

When $x_2=0$ then x_1=?

$\Rightarrow 2x_1+3(0)=30$

$\Rightarrow 2x_1=30 \Rightarrow x_1= 30/2=15$

x_1	0	15
x_2	10	0

From $3x_1 + 2x_2 <= 24$

When $x_1=0$ then x_2=?

$\Rightarrow 3(0)+2x_2=24$

$\Rightarrow 2x_2=24 \Rightarrow x_2=24/2=12$

When $x_2=0$ then x1=?

$\Rightarrow 3x_1+2(0)=24 \Rightarrow 3x1=24$

$\Rightarrow x_1=24/3=8$

x_1	0	8
x_2	12	0

From $x_1 + x_2 >= 3$

When $x_1=0$ then x2=?

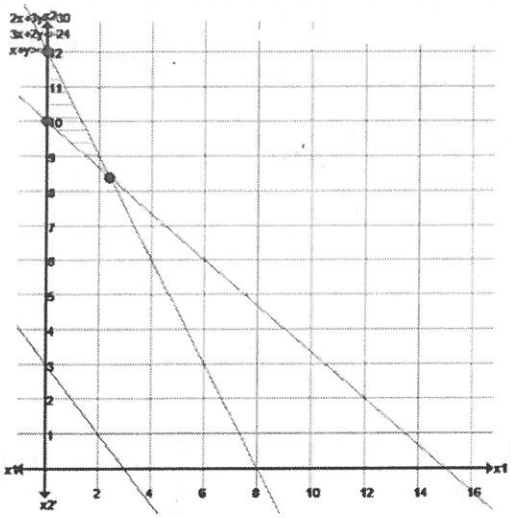
$\Rightarrow (0)+ x_2=3 \Rightarrow x_2=3$

When $x_2=0$ then x_1=?

$\Rightarrow x_1+(0)=3 \Rightarrow x_1=3$

x_1	0	3
x_2	3	0

4 Marks



The value of the objective function at each of these extreme points is as follows:
Objective function value :$Z=20\ x_1+10\ x_2$
A(0,10) $\Rightarrow 20(0)+10(10)=100$
B(0,12) $\Rightarrow 20(0)+10(12)=120$
C(2.4,8.4) $\Rightarrow 20(2.4)+10(8.4)=132$
The maximum value of the objective function Z=132 occurs at the extreme point (2.4, 8.4).
Hence, the optimal solution to the given LP problem is : **$x_1=2.4$, $x_2=8.4$ and max Z=132**.

2 marks

4 marks

3. Use simplex method to solve the following LPP Maximize $z = 3x_1+5x_2+4x_3$ subject to $2x_1+3x_2 <= 8$, $2x_2+5x_3 <= 10$, $3x_1+2x_2+4x_3 <= 15$ and $x_1, x_2, x_3 >= 0$

10 marks

Sol: Converting given inequalities into std. form

$$\text{Max. } Z = 3x_1+5x_2+4x_3+0S_1+0S_2+0S_3$$

s/t $2x_1+3x_2+S_1=8$

$2x_2+5x_3+S_2=10$

$3x_1+2x_2+4x_3+S_3=15$

$x_1, x_2, x_3, S_1, S_2, S_3 \geq 0$

Let S_1, S_2, S_3 are basic variable.

& let $x_1=x_2=x_3=0$

$\Rightarrow S_1=8,\ S_2=10,\ S_3=15$

Iteration-1:

		$\rightarrow C_B$:	3	5	4	0	0	0	
C_B	Basis	Sol.	x_1	x_2	x_3	S_1	S_2	S_3	Replacement Ratio(θ) = Sol./Keycol.
0	S_1	8	2	(3) ← KE	0	1	0	0	8/3 ← KR
0	S_2	10	0	2	5	0	1	0	10/2
0	S_3	15	3	2	4	0	0	1	15/2
		Z_j =	0	0	0	0	0	0	
		$\Delta_j = C_j - Z_j$ =	3	5 ↑ K.C	4	0	0	0	

			3	5	4	0	0	0	
C_B	Basis	Sol.	x_1	x_2	x_3	S_1	S_2	S_3	θ
5	x_2	2.67	0.67	1	0	0.33	0	0	$2.67/0 = \infty$
0	S_2	4.67	-1.33	0	5	-0.67	1	0	$4.67/5$ ← K.R
0	S_3	9.67	1.67	0	4	-0.67	0	1	$9.67/4$
		$Z_j =$	3.33	5	0	1.67	0	0	
		$\Delta_j = C_j - Z_j =$	0.33	0	4	-1.67	0	0	

K.E

K.C

Iteration 3:

			3	5	4	0	0	0	
C_B	Basis	Sol.	x_1	x_2	x_3	S_1	S_2	S_3	θ
5	x_2	2.67	0.67	1	0	0.33	0	0	$2.67/0.67$
4	x_3	0.93	-0.27	0	1	-0.13	0.2	0	-ve
0	S_3	5.93	2.73	0	0	-0.13	-0.8	1	$5.93/2.73$ ← K.R
		$Z_j =$	2.67	5	4	1.13	0.8	0	
		$\Delta_j = C_j - Z_j =$	0.73	0	0	-1.13	-0.8	0	

K.E

K.C

Iteration 4:

			3	5	4	0	0	0	
C_B	Basis	Sol.	x_1	x_2	x_3	S_1	S_2	S_3	θ
5	x_2	1.22	0	1	0	037	0.19	-0.24	
4	x_3	1.51	0	0	1	-0.15	0.12	0.09	
3	x_1	2.17	1	0	0	-0.05	-0.29	0.366	
		$Z_j =$	3	5	4	1.097	0.585	0.268	
		$\Delta_j =$	0	0	0	-1.097	-0.585	-0.268	

As all Δ_j values are '0' & -ves optimal sol. is Reached.

$\therefore x_1 = 2.17, x_2 = 1.22, x_3 = 1.51$

$Z_{max} = 18.6585$

UNIT-II

4. Determine an optimal solution to the following Transportation problem. 10 marks

	D1	D2	D3	D4	Supply
S1	1	2	1	4	30
S2	3	3	2	1	30
S3	4	2	5	9	20
Demand	20	40	30	10	

Sol:

Here Total Demand = 100 is greater than Total Supply = 80.

So We add a dummy supply constraint with 0 unit cost and with allocation 20.

Now, The modified table is

	D1	D2	D3	D4	Supply
S1	1	2	1	4	30
S2	3	3	2	1	30
S3	4	2	5	9	20
S_{dummy}	0	0	0	0	20
Demand	20	40	30	10	100

Using Vogel's approximation Method

	D1	D2	D3	D4	Supply	Row Penalty
S1	(20) 1	2	(10) 1	4	~~30~~ 10	0 0 0 1 1 1 X
S2	3	3	(20) 2	(10) 1	~~30~~ 20	1 1 1 1 2 X
S3	4	(20) 2	5	9	~~20~~	2 2 2 3 X
Sdummy	0	(20) 0	0	0	~~20~~	0 X
Demand	~~20~~	~~40~~ 20	~~30~~ 10	~~10~~	100	
Column Penalty	1 2 ↑2 X	2 ↑0 0 0	1 1 1 1 X 1	1 3↑ X		

The minimum total transportation cost $= 1\times20 + 1\times10 + 2\times20 + 1\times10 + 2\times20 + 0\times20 = 120/-$

No. of Basic cells = 6

$m+n-1 = 7$

$\Rightarrow$ no. of Basic cells $\neq m+n-1$

There is degeneracy, to resolve degeneracy add a small amount 'ε' to the least cost un occupied cell.

	D_1	D_2	D_3	D_4	
S_1	(20) 1	(ε) 2	(10) 1	4 4	$u_1 = 0$
S_2	1 3	0 3	(20) 2	(10) 1	$u_2 = -1$
S_3	+3 4	(20) 2	4 5	9 9	$u_3 = 0$
S_{dumm}	1 0	(20) 0	1 0	2 0	$u_4 = -2$
	$v_1 = 1$	$v_2 = 2$	$v_3 = 1$	$v_4 = 0$	

Since all Δ_{ij} values are ≥ 0, optimal sol. is reached.

∴ min. total transportation cost is = Rs. 120/-

Note: Basic feasible solution can be done using NWS & LC method

5. A market manager has 5 salesmen and there are 5 sales districts. Considering the capabilities of the salesmen and the nature of districts, the estimates made by the marketing manager for the sales per month(in 1000 rupees) for each salesman in each district would be as follows. Find the assignment to the districts that will result in each district the maximum sales.

10 Marks

Work \ Job	1	2	3	4	5
A	32	38	40	28	40
B	40	24	28	21	36
C	41	27	33	30	37
D	22	38	41	36	36
E	29	33	40	35	39

Here the problem is maximization. Hence convert into minimization by substracting all cell elements from maximum value '41'.

	1	2	3	4	5
A	9	3	1	13	1
B	1	17	13	20	5
C	0	14	8	11	4
D	19	3	0	5	5
E	12	8	1	6	2

Row Reduction:

	1	2	3	4	5
A	8	2	0	12	0
B	0	16	12	19	4
C	0	14	8	11	4
D	19	3	0	5	5
E	11	7	0	5	1

Column Reduction:

	1	2	3	4	5	
A	8	0	0	7	0	1
B	0	14	12	14	4	
C	0	12	8	6	4	
D	19	1	0	0	5	2
E	11	5	0	0	1	3

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⇒

	1	2	3	4	5	
A	12	0	0	7	0	1
B	0	10	8	10	0	2
C	0	8	4	2	0	3
D	23	1	0	0	5	4
E	15	5	0	0	1	5

No. of lines crossed < no. of rows
Hence, take least uncovered element and substract from other uncovered elements and add at intersection.

No. of lines = no. of rows

Note: lines can be drawn col. wise also

	1	2	3	4	5
A	12	[0]	~~0~~	7	~~0~~
B	~~0~~	10	8	10	[0]
C	[0]	8	4	2	~~0~~
D	23	1	[0]	~~0~~	5
E	17	5	~~0~~	[0]	1

optimum allocation:

A - 2 - 38
B - 5 - 36
C - 1 - 41
D - 3 - 41
E - 4 - 35
Total 191

UNIT-III

6. There are seven jobs each of which has to go through the machines M_1,M_2 in the order of M_1,M_2. Processing time (in hours) is given as 10 Marks

Job	1	2	3	4	5	6	7
Machine M_1	3	12	15	6	10	11	9
Machine M_2	8	10	10	6	12	1	3

Determine the sequence of these jobs that will minimize the total elapsed time. Also find the idle times of machines.

Job Sequence is:

1	4	5	3	2	7	6

Job	Machine M_1			Machine M_2			Idle times	
	In	P.T	Out	In	P.T	Out	M_1	M_2
1	0	3	3	3	8	11	–	3
4	3	6	9	11	6	17	–	–
5	9	10	19	19	12	31	–	2
3	19	15	34	34	10	44	–	3
2	34	12	46	46	10	56	–	2
7	46	9	55	56	3	59	–	
6	55	11	66	66	1	67	1	7

Total Elapsed time = 67 hours

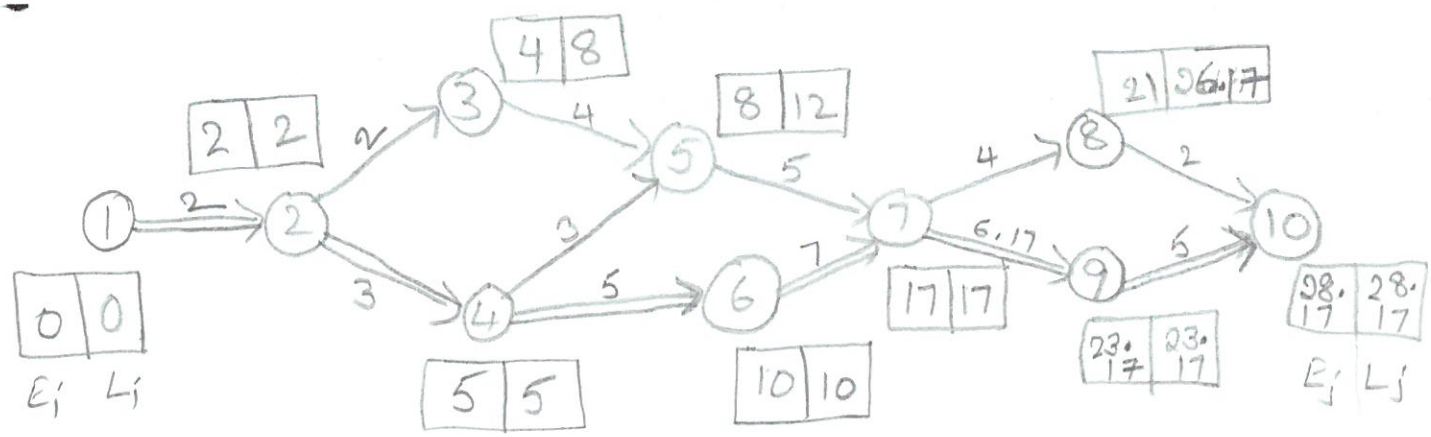
Idle time for m/c 1 = 1 hr

Idle time for m/c 2 = 17 hrs

7. A project has the following characteristics 10 marks

Activity	1-2	2-3	2-4	3-5	4-5	4-6	5-7	6-7	7-8	7-9	8-10	9-10
Most Optimistic time	1	1	1	3	2	3	4	6	2	5	1	3
Most likely time	1.5	2	3	4	3	5	5	7	4	6	2	5
Most Pessimistic time	5	3	5	5	4	7	6	8	6	8	3	7

Construct a PERT Network. Also find the critical path and variance for each event.



Activity	Most Optimistic time	Most likely time	Most Pessimistic time	$t_e = \frac{t_o + 4t_m + t_p}{6}$	$\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$
1-2	1	1.5	5	2	0.44
2-3	1	2	3	2	0.11
2-4	1	3	5	3	0.44
3-5	3	4	5	4	0.11
4-5	2	3	4	3	0.11
4-6	3	5	7	5	0.44
5-7	4	5	6	5	0.11
6-7	6	7	8	7	0.11
7-8	2	4	6	4	0.44
7-9	5	6	8	6.17	0.25
8-10	1	2	3	2	0.11
9-10	3	5	7	5	0.44

Critical path is 1-2-4-6-7-9-10

Total project duration is 28.17 hrs

UNIT-IV

8. The following table gives the annual demand and unit price of the item. 10 Marks

Item	A
Annual demand	400 units
Unit price	Rs. 8.00

Order cost is Rs5 per order and holding cost is 10% of unit price. Determine (i) EOQ. (ii) Total Inventory cost. (iii) Number of orders in a year.

Given:

Annual demand (D) = 400 units

Unit price (P) = Rs. 8

Ordering cost (S) = Rs. 5 per order

Holding cost (H) = 10% of unit price = 10% of Rs. 8 = Rs. 0.80 per unit per year

i) EOQ

$$EOQ = \sqrt{\frac{2ZC_0}{C_c}} = \sqrt{\frac{2X400X5}{0.8}} = 70.71 \approx 71\ units$$

ii) Total Inventory Cost

$$Total\ Inventory\ cost = \frac{Z}{EOQ}C_o + \frac{EOQ}{2}C_h = \frac{400}{71}X5 + \frac{71}{2}X0.8 = Rs.56.55$$

iii) Number of Orders per Year (N):

$$N = \frac{Z}{EOQ} = \frac{400}{71} = 5.63 \approx 6\ orders/year$$

9. If sales are 10,000 units and selling price is Rs. 20 per unit, variable cost is Rs.10 per unit and fixed cost is Rs.80,000/-. Find out BEP in units and sales revenue. What is the profit earned? What should be the sales for earning profit of Rs.60,000/-? 10 Marks

Sol: Given:

Sales units = 10,000 units

Selling price per unit = Rs. 20

Variable cost per unit = Rs. 10

Fixed cost = Rs. 80,000

1. Contribution per Unit:

Contribution per unit=Selling price−Variable cost=20−10=Rs. 10

2. Break-Even Point (BEP):

(a) BEP in units:

BEP (units)=Fixed Cost/Contribution per unit=80,000/10=8,000 units

(b) BEP in sales revenue:

BEP (revenue)=BEP units×Selling price=8,000×20=Rs. 160,000

3. Profit Earned at 10,000 units:

Profit=(Contribution per unit×Units sold)−Fixed cost

Profit=(10×10,000)−80,000=100,000−80,000=Rs. 20,000

4. Required Sales to Earn Profit of Rs. 60,000:

Use the formula:

Required sales (units)=(Fixed cost+Desired profit)/ Contribution per unit

=(80,000+60,000)/10=140,000/10=14,000 units

Required sales revenue=14,000×20=Rs. 280,000

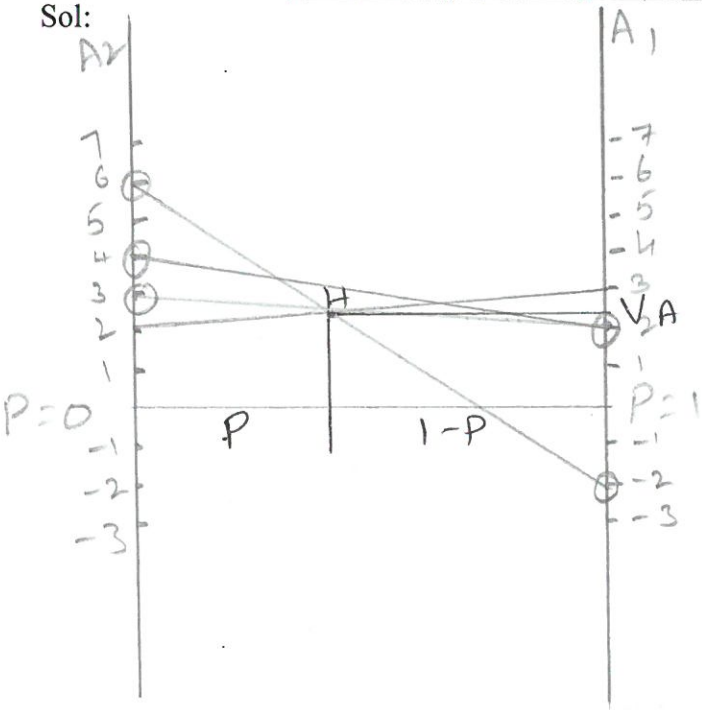
UNIT-V

10. Using the graphical method, Solve the following game and the value of the game.

10 marks

Player A	Player B				
		1	2	3	4
	A1	2	2	3	-2
	A2	4	3	2	6

Sol:



From graph:

Value of game $V_A = 2.4$

lines Strategies passing through point H is

$$\begin{bmatrix} 3 & -2 \\ 2 & 6 \end{bmatrix}$$

4 1

$q = \frac{4}{5}$, $1-q = \frac{1}{5}$

From graph

$P = \frac{4}{5}$, $1-P = \frac{1}{5}$

$= 0.8$ $= 0.2$

∴ For the given game

Value of game = 2.4

Row player strategies = (0.8, 0.2)

column player strategies = (0, 0, 0.8, 0.2).

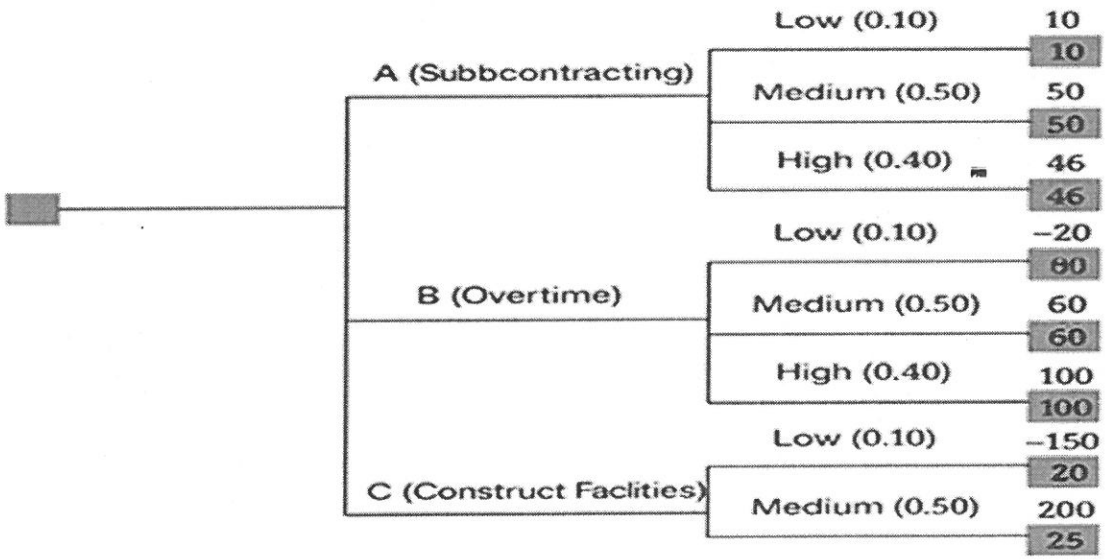
11. A Glass factory specializing in crystal is developing a substantial backlog and the firm's management is considering three courses of action: (A) arrange for sub-contracting (B) overtime (C) construct new facilities. The correct choice depends largely upon future demand which may be low, medium or high. By consensus, management ranks the respective probabilities as 0.10, 0.50 and 0.40. A cost analysis reveals the effect upon the profits that is shown in the table below.

Profit (Rs. Courses of action '000) if demand is	Course of Action		
	A (subcontracting)	B (over time)	C (construct facilities)
Low (p=0.10)	10	-20	-150
Medium (p=0.5)	50	60	20
High (p=0.4)	50	100	200

Show this decision is in the form of a decision tree and indicates the most preferred decision and corresponding expected value. 10 marks

Sol: Profit Table

Demand Level	Probability	Profit A (Subcontract)	Profit B (Overtime)	Profit C (Construct)
Low	0.10	10	-20	-150
Medium	0.50	50	60	20
High	0.40	50	100	200



Expected Value (EV) Calculation

EV(A):

$= (0.10 \times 10) + (0.50 \times 50) + (0.40 \times 50) = 1 + 25 + 20 =$ **Rs. 46,000**

EV(B):

$= (0.10 \times -20) + (0.50 \times 60) + (0.40 \times 100) = -2 + 30 + 40 =$ **Rs. 68,000**

EV(C):

$= (0.10 \times -150) + (0.50 \times 20) + (0.40 \times 200) = -15 + 10 + 80 =$ **Rs. 75,000**

Decision Tree

Step 5: Recommendation:

- **Most Preferred Decision: Construct Facilities (Option C)**
- **Maximum Expected Value: Rs. 75,000**